

ABSTRACT

A single piezoelectric is excited at a first frequency to cause two vibration
5 modes in a resonator producing a first elliptical motion in a first direction at a selected
contacting portion of the resonator that is placed in frictional engagement with a
driven element to move the driven element in a first direction. A second frequency
excites the same piezoelectric to cause two vibration modes of the resonator
producing a second elliptical motion in a second direction at the selected contacting
10 portion to move the driven element in a second direction. The piezoelectric is
preloaded in compression by the resonator. Walls of the resonator are stressed past
their yield point to maintain the preload. Specially shaped ends on the piezoelectric
help preloading. The piezoelectric can send or receive vibratory signals through the
driven element to or from sensors to determine the position of the driven element
15 relative to the piezoelectric element or resonator. Conversely, the piezoelectric
element can receive vibration or electrical signals passed through the driven element
to determine the position of the driven element. The resonator is resiliently urged
against the driven element, or vice versa. Plural resonators can drive common driven
elements.